What is claimed is:

1. A system for workload placement among data centers, said system comprising:

a plurality of grid resource allocation managers (GRAMs), wherein the GRAMs are configured to obtain information from the data centers;

an information service configured to receive information from the plurality of GRAMs;

a broker configured to receive an application request and to determine resource requirements from the application request, wherein the broker is configured to determine which of the data centers contains adequate resources to perform the requested application; and

a co-allocator configured to receive information pertaining to the data centers having the adequate resources, wherein the co-allocator is further configured to select one of the data centers to perform the requested application based upon energy efficiency characteristics of the data centers.

2. The system according to claim 1, wherein the GRAMs are configured to receive sensed data from their respective data centers.

3. The system according to claim 2, wherein the sensed data comprises temperature measurements from locations in the data centers and locations outside of the data centers.

4. The system according to claim 3, wherein the GRAMs are configured to determine a supply heat index of the data centers, wherein the information received by the information service from the GRAMs contains the supply heat indexes of the data centers.

5. The system according to claim 4, wherein the GRAMs are further configured to determine supply heat indexes of the data centers under various anticipated loading conditions.

6. The system according to claim 2, wherein the sensed data comprises relative humidity measurements from locations outside of the data centers, and wherein the co-allocator is further configured to consider the relative humidity measurements around the data centers in selecting a data center.

7. The system according to claim 1, wherein the GRAMs are configured to determine the resources contained in the data centers, and wherein the information received by the information service from the GRAMs contains information pertaining to the resources contained in the data centers.

8. The system according to claim 7, wherein the resources comprise one or more of machines, storage devices, and processors, and wherein the determination of the resources further comprises determining current and scheduled workloads of the resources.

9. The system according to claim 1, wherein the application request is in the form of a resource specification language, said resource specification language defining resource requirements for performance of the application.

10. The system according to claim 9, wherein the broker is configured to identify one or more qualifying data centers having the adequate resources through a comparison of the resource requirements for performance of the application and information regarding the resources in the data centers received from the information service.

11. The system according to claim 10, wherein the co-allocator is configured to receive the identities of the one or more qualifying data centers and to determine an energy efficiency coefficient of each of the qualifying data centers.

12. The system according to claim 11, wherein the energy efficiency coefficient of a data center is based upon a supply heat index of the data center and a coefficient of performance of the data center, and wherein the co-allocator is configured to select the data center having the highest energy efficiency coefficient.

13. The system according to claim 11, wherein the energy efficiency coefficient (χ) of a data center (i) is defined by the following equation:

$\chi_i = \xi_i \frac{1}{\tau} \int COP_i(t)dt$, where:

$\xi_i = 1/SHI$, of the ith data center and where SHI is the supply heat index of the ith data center;

$COP_i = \frac{Q_{evap}}{W_c}$, where COP is the coefficient of performance of the ith data center, Q_{evap} is the desired heat output of the data center and W_c is the work input;

τ is a duration in which the application is to be scheduled; and

t is the time of day in which the application is to be scheduled, and

wherein the co-allocator is configured to select the data center having the highest energy efficiency coefficient.

14. The system according to claim 13, wherein the energy efficiency coefficient (χ) is based upon a modified COP, said modified COP being a ratio of power consumption of the resources in a data center over the power consumption of an air conditioning unit in the data center.

15. The system according to claim 13, wherein the energy efficiency coefficient (χ) includes a penalty factor for a data center having a relative humidity level higher than a predetermined set point.

16. The system according to claim 13, wherein the co-allocator is configured to withdraw from consideration one or more data centers having relative humidity levels that fall a predetermined error level outside of a predetermined relative humidity level from performing the application.

17. The system according to claim 1, wherein the data centers are located in various geographically diverse locations.

18. The system according to claim 17, wherein the various geographically diverse locations comprise at least one of different counties, states, countries and continents.

19. The system according to claim 1, wherein the application request is in the form of a ground resource specification language, said ground resource specification language defining resource requirements for performance of the application, wherein the co-allocator is configured to receive the application request in the form of the ground resource specification language and wherein the co-allocator is further configured to select one of the data centers to perform the requested application based substantially upon a comparison between the resources defined in the ground resource specification language and the energy efficiency characteristics of the data centers.

20. A method of workload placement among data centers, said data centers being associated with grid resource allocation managers (GRAMs), said method comprising:

registering information regarding available resources in the data centers received from the GRAMs in an information service;

receiving a request to perform an application and receiving the information from the information service;

comparing the available resources in the data centers with resources for performing the application;

determining which of the data centers contains adequate available resources to perform the application; and

selecting one of the data centers to perform the application based upon energy efficiency characteristics of the data centers.

21. The method according to claim 20, further comprising:

in the GRAMs, detecting one or more environmental conditions inside and outside of the data centers, calculating a heat index based upon the detected one or more environmental conditions, and determining resources available in the data centers and communicating information pertaining to heat index and the available resources to the information service.

22. The method according to claim 20, wherein the step of detecting one or more environmental conditions comprises obtaining relative humidity measurements around the data centers and wherein the step of selecting one of the data centers to perform the application comprises considering the relative humidity measurements around the data centers in selecting the data center.

23. The method according to claim 20, wherein the step of determining which of the data centers contains adequate available resources to perform the application further comprises determining which of the data centers contains appropriate types of resources to perform the application, sufficient amounts of resources to perform the application, sufficient amounts of resource instances to perform the application, and are not subject to restrictions which would prevent the data centers from performing the application.

24. The method according to claim 23, further comprising:

determining whether resource specifications should be varied in response to a determination that none of the data centers contains the available resources to perform the application; and

varying the resource specifications in response to a determination that the resource specifications should be varied.

25. The method according to claim 23, further comprising:

determining whether a single data center has sufficient available resources to perform the application; and

submitting the application to the single data center in response to a determination that a single data center has sufficient available resources to perform the application.

26. The method according to claim 20, further comprising:

calculating supply heat indexes of the data centers;

determining coefficient of performances of the data centers; and

calculating energy efficiency coefficients of the data centers, wherein the step of selecting

one of the data centers to perform the application comprises selecting the data center having the highest energy efficiency coefficient.

27. The method according to claim 26, wherein the step of calculating the energy efficiency coefficient further comprises calculating energy efficiency coefficients (χ) of each data center (i) through the following equation:

$\chi_i = \xi_i \frac{1}{\tau} \int COP_i(t)dt$, where:

$\xi_i = 1/SHI$, of the ith data center and where SHI is the supply heat index of the ith data center;

$COP_i = \frac{Q_{evap}}{W_c}$, where COP is the coefficient of performance of the ith data center, Q_{evap} is the desired heat output of the data center and W_c is the work input;

τ is a duration in which the application is to be scheduled; and

t is the time of day in which the application is to be scheduled, and

wherein the step of selecting a data center further comprises selecting the data center having the highest energy efficiency coefficient.

28. The method according to claim 27, wherein the step of calculating the energy efficiency coefficients (χ) of each data center comprises calculating the energy efficiency coefficients (χ) with a modified COP, said modified COP being a ratio of power consumption of the resources in a data center over the power consumption of an air conditioning unit in the data center.

29. The method according to claim 20, further comprising:

calculating energy efficiency coefficients of the data centers based upon anticipated thermal characteristics of the data centers if the application were performed by the data centers; and

wherein the step of selecting a data center further comprises selecting the data center having the highest energy efficiency coefficient while performing the application.

30. The method according to claim 20, wherein the application is in the form of a resource specification language defining resources required to perform the application, and wherein a broker is configured to perform the steps of receiving a request to perform an application and receiving the information from the information service, said broker being further configured to perform the steps of comparing the available resources in the data centers with resources required to perform the application and determining which of the data centers contains adequate resources to perform the application.

31. The method according to claim 20, wherein the application is in the form of a ground resource specification language defining which of the data centers comprise adequate resources to perform the request, wherein a co-allocator is configured to perform the steps of receiving a request to perform an application and receiving the information from the information service, the co-allocator being further configured to perform the steps of selecting one of the data centers to perform the application based upon energy efficiency characteristics of the data centers.

32. A system for workload placement among data centers, said data centers being associated with means for allocating resources, said system comprising:

means for registering information regarding available resources in the data centers received from the means for allocating resources of the data centers;

means for comparing the available resources to resources required for performing a requested application;

means for communicating between the means for comparing and the means for allocating resources;

means for selecting one of the data centers to perform the application based upon energy efficiency characteristics of the data centers.

33. The system according to claim 32, wherein the means for allocating resources comprises means for detecting one or more environmental conditions, means for calculating a heat index, means for determining resources available in the data centers, and means for communicating between the means for allocating resources and the means for registering

information.

34. The system according to claim 32, wherein the means for allocating resources comprises means for calculating supply heat indexes of the data centers, means for determining coefficient of performances of the data centers, and means for calculating energy efficiency coefficients of the data centers, wherein the means for selecting one of the data centers comprises means for selecting the data center having the highest energy efficiency coefficient.

35. The system according to claim 32, wherein the means for allocating resources comprises means for calculating energy efficiency coefficients, wherein the means for calculating energy efficiency coefficients is configured to determine the energy efficiency coefficient (χ) of each of the data center (i) through the following equation:

$\chi_i = \xi_i \frac{1}{\tau} \int COP_i(t)dt$, where:

$\xi_i = 1/SHI$, of the ith data center and where SHI is the supply heat index of the ith data center;

$COP_i = \frac{Q_{evap}}{W_c}$, where COP is the coefficient of performance of the ith data center, Q_{evap} is the desired heat output of the data center and W_c is the work input;

τ is a duration in which the application is to be scheduled; and

t is the time of day in which the application is to be scheduled, and

wherein the means for selecting is configured to select the data center having the highest energy efficiency coefficient.

36. The system according to claim 32, further comprising:

means for obtaining relative humidity measurements around the data centers; and

wherein the means for selecting one of the data centers to perform the application based upon energy efficiency characteristics of the data centers further comprises means for factoring the relative humidity measurements in selecting one of the data centers.

37. The system according to claim 32, further comprising:

wherein the means for calculating energy efficiency coefficients of the data centers comprises means for calculating energy efficiency coefficients of the data centers based upon anticipated thermal characteristics of the data centers if the application were performed by the data centers; and

wherein the for selecting one of the data centers to perform the application based upon energy efficiency characteristics of the data centers further comprises means for selecting the data center having the highest energy efficiency coefficient while performing the application.

38. The system according to claim 32, wherein the means for comparing the available resources to resources required for performing a requested application comprises a broker.

39. The system according to claim 32, wherein the means for comparing the available resources to resources required for performing a requested application comprises a co-alllocator.

40. A computer readable storage medium on which is embedded one or more computer programs, said one or more computer programs implementing a method of workload placement among data centers, said data centers being associated with grid resource allocation managers (GRAMs), said one or more computer programs comprising a set of instructions for:

registering information regarding available resources in the data centers received from the GRAMs in an information service;

receiving a request to perform an application and receiving the information from the information service;

comparing the available resources in the data centers with resources for performing the application;

determining which of the data centers contains adequate available resources to perform the application; and

selecting one of the data centers to perform the application based upon energy efficiency characteristics of the data centers.

41. The computer readable storage medium according to claim 40, said one or more computer programs further comprising a set of instructions for:

detecting one or more environmental conditions inside and outside of the data centers, calculating a heat index based upon the detected one or more environmental conditions, and determining resources available in the data centers and communicating information pertaining to heat index and the available resources to the information service.

42. The computer readable storage medium according to claim 40, said one or more computer programs further comprising a set of instructions for:

determining which of the data centers contains appropriate types of resources to perform the application, sufficient amounts of resources to perform the application, sufficient amounts of resource instances to perform the application, and are not subject to restrictions which would prevent the data centers from performing the application.

43. The computer readable storage medium according to claim 40, said one or more computer programs further comprising a set of instructions for:

calculating supply heat indexes of the data centers;

determining coefficient of performances of the data centers; and

calculating energy efficiency coefficients of the data centers, wherein the step of selecting one of the data centers to perform the application comprises selecting the data center having the highest energy efficiency coefficient.

44. The computer readable storage medium according to claim 40, said one or more computer programs further comprising a set of instructions for:

calculating energy efficiency coefficients (χ) of each data center (i) through the following equation:

$\chi_i = \xi_i \frac{1}{\tau} \int COP_i(t)dt$, where:

$\xi_i = 1/SHI$, of the ith data center and where SHI is the supply heat index of the ith data center;

$COP_i = \frac{Q_{evap}}{W_c}$, where COP is the coefficient of performance of the ith data center, Q_{evap} is the desired heat output of the data center and W_c is the work input;

τ is a duration in which the application is to be scheduled; and

t is the time of day in which the application is to be scheduled, and

wherein the step of selecting a data center further comprises selecting the data center having the highest energy efficiency coefficient.

45. The computer readable storage medium according to claim 44, said one or more computer programs further comprising a set of instructions for:

calculating the energy efficiency coefficients (χ) with a modified COP, said modified COP being a ratio of power consumption of the resources in a data center over the power consumption of an air conditioning unit in the data center.

46. The computer readable storage medium according to claim 40, said one or more computer programs further comprising a set of instructions for:

calculating energy efficiency coefficients of the data centers based upon anticipated thermal characteristics of the data centers if the application were performed by the data centers; and

wherein the step of selecting a data center further comprises selecting the data center having the highest energy efficiency coefficient while performing the application.

47. The computer readable storage medium according to claim 40, said one or more computer programs further comprising a set of instructions for:

performing the steps of receiving a request to perform an application and receiving the information from the information service, comparing the available resources in the data centers with resources required to perform the application and determining which of the data centers contains adequate resources to perform the application, in a broker.

48. The computer readable storage medium according to claim 40, said one or more computer programs further comprising a set of instructions for:

performing the steps of receiving a request to perform an application and receiving the information from the information service, and selecting one of the data centers to perform the application based upon energy efficiency characteristics of the data centers, in a co-allocator.